



## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<b>(51) International Patent Classification<sup>5</sup>:</b> <b>C12Q 1/00 // C12N 9/02</b>	<b>A1</b>	<b>(11) International Publication Number:</b> <b>WO 94/14977</b> <b>(43) International Publication Date:</b> 7 July 1994 (07.07.94)
<b>(21) International Application Number:</b> PCT/CA93/00547 <b>(22) International Filing Date:</b> 17 December 1993 (17.12.93)  <b>(30) Priority Data:</b> 994,760 22 December 1992 (22.12.92) US 064,271 6 May 1993 (06.05.93) US  <b>(60) Parent Application or Grant</b> <b>(63) Related by Continuation</b> US 064,271 (CIP) Filed on 6 May 1993 (06.05.93)  <b>(71) Applicant (for all designated States except US):</b> MERCK FROSST CANADA INC. [CA/CA]; 16711 Trans-Canada Highway, Kirkland, Quebec H9H 3L1 (CA).  <b>(72) Inventors; and</b> <b>(75) Inventors/Applicants (for US only):</b> CROMLISH, Wanda, A. [CA/CA]; 5377 St. Ignatius, Montreal, Quebec H4V 2C5 (CA). KENNEDY, Brian, P. [CA/CA]; 33 Brome, Kirkland, Quebec H9J 2R5 (CA). O'NEILL, Gary [CA/CA]; 51 Fredmir Street, Dollard Des Ormeaux, Quebec H9A 2R4 (CA). VICKERS, Philip, J. [CA/CA]; 4862 Perron, Pierrefonds, Quebec H9A 3E5 (CA). WONG, Elizabeth	<b>[CA/CA];</b> Apartment 1103, 4858 Cote Des Neiges Road, Montreal, Quebec H3V 3G8 (CA). MANCINI, Joseph, A. [CA/CA]; 8593 Grouard, St. Leonard, Quebec H1P 2M6 (CA).  <b>(74) Agent:</b> MURPHY, Kevin, P.; Swabey Ogilvy & Renault, Suite 800, 1001 de Maisonneuve Boulevard West, Montreal, Quebec H3A 3C8 (CA).  <b>(81) Designated States:</b> AU, BB, BG, BR, BY, CA, CZ, FI, HU, JP, KR, KZ, LK, LV, MG, MN, MW, NO, NZ, PL, RO, RU, SD, SK, UA, US, UZ, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).  <b>Published</b> <i>With international search report.</i>	
<b>(54) Title:</b> HUMAN CYCLOOXYGENASE-2cDNA AND ASSAY FOR EVALUATING INHIBITION OF CYCLOOXYGENASE-2		
<b>(57) Abstract</b>  The invention discloses an assay for measuring inhibition of cyclooxygenase-2 in comparison with cyclooxygenase-1. The invention also comprises a human cyclooxygenase-2 cDNA and a human cyclooxygenase-2.		

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**TITLE OF THE INVENTION****HUMAN CYCLOOXYGENASE-2 cDNA AND ASSAY FOR  
EVALUATING INHIBITION OF CYCLOOXYGENASE-2****BACKGROUND OF THE INVENTION**

5           This invention relates to human cyclooxygenase-2 cDNA and assays for evaluation cyclooxygenase-1 and cyclooxygenase-2 activity.

10           Non-steroidal, antiinflammatory drugs exert most of their antiinflammatory, analgesic and antipyretic activity and inhibit hormone-induced uterine contractions and certain types of cancer growth through inhibition of prostaglandin G/H synthase, also known as cyclooxygenase. Up until recently, only one form of cyclooxygenase had been characterized, this corresponding to cyclooxygenase-1 or the constitutive enzyme, as originally identified in bovine seminal vesicles.

15           Recently the gene for an inducible form of cyclooxygenase (cyclooxygenase-2) has been cloned, sequenced and characterized from chicken, murine and human sources. This enzyme is distinct from the cyclooxygenase-1 which has also been cloned, sequenced and

20           characterized from sheep, murine and human sources. The second form of cyclooxygenase, cyclooxygenase-2, is rapidly and readily inducible by a number of agents including mitogens, endotoxin, hormones, cytokines and growth factors. As prostaglandins have physiological and pathological roles, we have concluded that the constitutive enzyme, cyclooxygenase-1, is responsible, in large part, for endogenous basal

25           release of prostaglandins and hence is important in their physiological functions such as the maintenance of gastrointestinal integrity and renal blood flow. In contrast, we have concluded that the inducible form, cyclooxygenase-2, is mainly responsible for the pathological effects of prostaglandins where rapid induction of the enzyme would occur in

30           response to such agents as inflammatory agents, hormones, growth factors, and cytokines. Thus, a selective inhibitor of cyclooxygenase-2 will have similar antiinflammatory, antipyretic and analgesic properties of a conventional non-steroidal antiinflammatory drug (NSAID), and in

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addition would inhibit hormone-induced uterine contractions and have potential anti-cancer effects, but will have a diminished ability to induce some of the mechanism-based side effects. In particular, such a compound should have a reduced potential for gastrointestinal toxicity, a reduced potential for renal side effects, a reduced effect on bleeding times and possibly a lessened ability to induce asthma attacks in aspirin-sensitive asthmatic subjects.

Accordingly, it is an object of this invention to provide assays and materials to identify and evaluate pharmacological agents that are potent inhibitors of cyclooxygenase-2 and cyclooxygenase-2 activity.

It is also an object of this invention to provide assays and materials to identify and evaluate pharmacological agents that preferentially or selectively inhibit cyclooxygenase 2 and cyclooxygenase 2 activity over cyclooxygenase 1 and cyclooxygenase 1 activity.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 Full length amino acid sequence of a human cyclooxygenase-2 protein.

Figure 2 Full length nucleotide sequence of a cloned human cyclooxygenase-2 complementary DNA obtained from human osteosarcoma cells.

#### SUMMARY OF THE INVENTION

The invention encompasses a human osteosarcoma cell cyclooxygenase-2 cDNA and a human cyclooxygenase-2 protein .

The invention also encompasses assays to identify and evaluate pharmacological agents that are potent inhibitors of cyclooxygenase 2 and cyclooxygenase 2 activity. The invention also encompasses assays to identify and evaluate pharmacological agents that preferentially or selectively inhibit cyclooxygenase-2 and cyclooxygenase-2 activity over cyclooxygenase-1.

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**DETAILED DESCRIPTION OF THE INVENTION**

In one embodiment the invention encompasses an assay for determining the cyclooxygenase-2 activity of a sample comprising the steps of:

- 5 (a) adding
- (1) a human osteosarcoma cell preparation,
  - (2) a sample, said sample comprising a putative cyclooxygenase-2 inhibitor, and
  - (3) arachidonic acid; and
- 10 (b) determining the amount of prostaglandin E<sub>2</sub> produced in step (a).

For purposes of this specification human osteosarcoma cells are intended to include, but are not limited to human osteosarcoma cell lines available from ATCC Rockville, MD such as osteosarcoma 143B (ATCC CRL 8303) and osteosarcoma 143B PML BK TK (ATCC CRL 8304). We have found useful, osteosarcoma 143.98.2 which was originally obtained from Dr. William Sugden, McArdle Laboratory for Cancer Research, University of Wisconsin-Madison. We have now made a Budapest Treaty deposit of osteosarcoma 143.98.2 with ATCC on December 22, 1992 under the identification Human osteosarcoma 143.98.2 (now ATCC CRL 11226).

For purposes of this specification the osteosarcoma cell preparation shall be defined as an aqueous mono layer or suspension of human osteosarcoma cells, a portion of which will catalyze the synthesis of PGE<sub>2</sub>. Furthermore the preparation contains a buffer such as HANK'S balanced salt solution.

Within this embodiment is the genus where the human osteosarcoma cells are from the osteosarcoma 143 family of cell types including osteosarcoma 143B and 143B PML BK TK; we have used osteosarcoma 143.98.2.

For purposes of this specification the osteosarcoma cell preparation also includes human osteosarcoma microsomes, said a portion of which will catalyze the synthesis of PGE<sub>2</sub>. The microsomes

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may be obtained as described below from any of the osteosarcoma cell lines herein disclosed.

In a second embodiment the invention encompasses a composition comprising

- 5 (a) an osteosarcoma cell preparation, having  $10^3$  to  $10^9$  osteosarcoma cells per cc of cell preparation, and
- (b) 0.1 to 50  $\mu$ l of peroxide-free arachidonic acid per cc of cell preparation.

Typically the cell preparation will be grown as a mono-layer and used in an aliquot of  $8.2 \times 10^4$  to  $2 \times 10^6$  cells per well (of approximately 1 cc working volume) as described in the protocol below. Arachidonic acid is typically used in amounts of 1 to 20  $\mu$ l per well of approximately 1 cc working volume.

When osteosarcoma microsomes are used instead of whole cells, the cell preparation will typically comprise 50 to 500  $\mu$ g of microsomal protein per cc of cell preparation. Arachidonic acid is typically used in amounts of 1 to 20  $\mu$ l acid per cc of cell preparation.

In a third embodiment the invention encompasses an assay for determining the cyclooxygenase-1 activity of a sample comprising the steps of:

- 20 (a) adding
  - (1) a cell preparation, said cells capable of expressing cyclooxygenase-1, but not expressing cyclooxygenase-2,
  - 25 (2) a sample, said sample comprising a putative cyclooxygenase-1 inhibitor;
  - (3) arachidonic acid; and
- (b) determining the amount of prostaglandin E<sub>2</sub> produced in step (a).

For purposes of this specification cells capable of expressing cyclooxygenase-1 but incapable of expressing cyclooxygenase-2, includes the human histiocytic lymphoma cells such as U-937 (ATCC CRL 1593). Such cells are hereinafter described as COX-1 cells.

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For purposes of this specification the cell preparation shall be defined as an aqueous suspension of cell, typically at a concentration of  $8 \times 10^5$  to  $1 \times 10^7$  cells/ml. The suspension will contain a buffer as defined above.

5 In a fourth embodiment the invention encompasses a human cyclooxygenase-2 which is shown in Figure 1. This Cyclooxygenase-2 is also identified as SEQ. ID. NO:10:.

10 In a fifth embodiment the invention encompasses a human Cyclooxygenase-2 cDNA which is shown in Figure 2 or a degenerate variation thereof. This Cyclooxygenase-2 cDNA is also identified as SEQ. ID. NO:11:.

Within this embodiment is the reading frame portion of the sequence shown in Figure 2 encoding the cyclooxygenase-2 shown in Figure 1; said portion being bases 97 through 1909.

15 As will be appreciated by those of skill in the art, there is a substantial amount of redundancy in the set of codons which translate specific amino acids. Accordingly, the invention also includes alternative base sequences wherein a codon (or codons) are replaced with another codon, such that the amino acid sequence translated by the DNA sequence remains unchanged. For purposes of this specification, a  
20 sequence bearing one or more such replaced codons will be defined as a degenerate variation. Also included are mutations (exchange of individual amino acids) which produce no significant effect in the expressed protein.

25 In a sixth embodiment the invention encompasses a system for stable expression of cyclooxygenase-2 as shown in Figure 2 or a degenerate variation thereof comprising:

- 30 (a) an expression vector such as vacinia expression vector pTM1, baculovirus expression vector pJVETLZ, pUL941 and pAcmP1 INVITROGEN vectors pCEP4 and pcDNAI; and
- (b) a base sequence encoding human cyclooxygenase-2 as shown in Figure 2 or a degenerate variation thereof.

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In one genus of this embodiment cyclooxygenase-2 is expressed in Sf9 or Sf21 cells (INVITROGEN).

A variety of mammalian expression vectors may be used to express recombinant cyclooxygenase-2 in mammalian cells.

5 Commercially available mammalian expression vectors which may be suitable for recombinant cyclooxygenase-2 expression, include but are not limited to, pMC1neo (Stratagene), pXT1 (Stratagene), pSG5 (Stratagene), EBO-pSV2-neo (ATCC 37593) pBPV-1(8-2) (ATCC 37110), pdBPV-MMTneo(342-12) (ATCC 37224), pRSVgpt (ATCC 37199), pRSVneo (ATCC 37198), pSV2-dhfr (ATCC 37146), pUCTag 10 (ATCC 37460), and gZD35 (ATCC 37565).

DNA encoding cyclooxygenase-2 may also be cloned into an expression vector for expression in a recombinant host cell.

15 Recombinant host cells may be prokaryotic or eukaryotic, including but not limited to bacteria, yeast, mammalian cells including but not limited to cell lines of human, bovine, porcine, monkey and rodent origin, and insect cells including but not limited to drosophila derived cell lines. Cell lines derived from mammalian species which may be suitable and which are commercially available, include but are not limited to, CV-1 20 (ATCC CCL 70), COS-1 (ATCC CRL 1650), COS-7 (ATCC CRL 1651), CHO-K1 (ATCC CCL 61), 3T3 (ATCC CCL 92), NIH/3T3 (ATCC CRL 1658), HeLa (ATCC CCL 2), C127I (ATCC CRL 1616), BS-C-1 (ATCC CCL 26) and MRC-5 (ATCC CCL 171).

The expression vector may be introduced into host cells via 25 any one of a number of techniques including but not limited to transformation, transfection, protoplast fusion, and electroporation. The expression vector-containing cells are clonally propagated and individually analyzed to determine whether they produce cyclooxygenase-2 protein. Identification of cyclooxygenase-2 30 expressing host cell clones may be done by several means, including but not limited to immunological reactivity with anti-cyclooxygenase-2 antibodies, and the presence of host cell-associated cyclooxygenase-2 activity.

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Expression of cyclooxygenase-2 DNA may also be performed using in vitro produced synthetic mRNA. Synthetic mRNA can be efficiently translated in various cell-free systems, including but not limited to wheat germ extracts and reticulocyte extracts, as well as efficiently translated in cell based systems, including but not limited to microinjection into frog oocytes, with microinjection into frog oocytes being preferred.

To determine the cyclooxygenase-2 cDNA sequence(s) that yields optimal levels of enzymatic activity and/or cyclooxygenase-2 protein, cyclooxygenase-2 cDNA molecules including but not limited to the following can be constructed: the full-length open reading frame of the cyclooxygenase-2 cDNA (base 97 to base 1909). All constructs can be designed to contain none, all or portions of the 3' untranslated region of cyclooxygenase-2 cDNA (base 1910-3387).

Cyclooxygenase-2 activity and levels of protein expression can be determined following the introduction, both singly and in combination, of these constructs into appropriate host cells. Following determination of the cyclooxygenase-2 cDNA cassette yielding optimal expression in transient assays, this cyclooxygenase-2 cDNA construct is transferred to a variety of expression vectors, including but not limited to mammalian cells, baculovirus-infected insect cells, E. Coli, and the yeast S. cerevisiae.

Mammalian cell transfectants, insect cells and microinjected oocytes are assayed for both the levels of cyclooxygenase-2 enzymatic activity and levels of cyclooxygenase-2 protein by the following methods. The first method for assessing cyclooxygenase-2 enzymatic activity involves the incubation of the cells in the presence of 20 $\mu$ M arachidonic acid for 10 minutes and measuring the PGE<sub>2</sub> production by EIA.

The second method for detecting cyclooxygenase-2 activity involves the direct measurement of cyclooxygenase-2 activity in cellular lysates or microsomes prepared from mammalian cells transfected with cyclooxygenase-2 cDNA or oocytes injected with cyclooxygenase-2

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mRNA. This assay can be performed by adding arachidonic acid to lysates and measuring the PGE<sub>2</sub> production by EIA.

Levels of cyclooxygenase-2 protein in host cells is quantitated by immunoaffinity and/or ligand affinity techniques. cyclooxygenase-2 specific affinity beads or cyclooxygenase-2 specific antibodies are used to isolate <sup>35</sup>S-methionine labelled or unlabelled cyclooxygenase-2 protein. Labelled cyclooxygenase-2 protein is analyzed by SDS-PAGE. Unlabelled cyclooxygenase-2 protein is detected by Western blotting, ELISA or RIA assays employing cyclooxygenase-2 specific antibodies.

Following expression of cyclooxygenase-2 in a recombinant host cell, cyclooxygenase-2 protein may be recovered to provide cyclooxygenase-2 in active form, capable of participating in the production of PGE<sub>2</sub>. Several cyclooxygenase-2 purification procedures are available and suitable for use. As described above for purification of cyclooxygenase-2 from natural sources, recombinant cyclooxygenase-2 may be purified from cell lysates and extracts, by various combinations of, or individual application of salt fractionation, ion exchange chromatography, size exclusion chromatography, hydroxylapatite adsorption chromatography and hydrophobic interaction chromatography.

In addition, recombinant cyclooxygenase-2 can be separated from other cellular proteins by use of an immuno-affinity column made with monoclonal or polyclonal antibodies specific for full length nascent cyclooxygenase-2.

### THE WHOLE CELL ASSAYS

For the cyclooxygenase-2 and cyclooxygenase-1 assays, human osteosarcoma cells were cultured and used in aliquots of typically  $8 \times 10^4$  to  $2 \times 10^6$  cells/well. We have found it convenient to culture the cells in 1 ml of media in 24-well multidishes (NUNCCLON) until essentially confluent. The number of cells per assay may be determined from replicate plates prior to assays, using standard procedures. Prior to the assay, the cells are washed with a suitable

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buffer such as Hanks balanced salts solution (HBSS; SIGMA) , preferably prewarmed to 37°C. Approximately 0.5 to 2 ml is then added per well.

5 Prior to the assays, the appropriate number of COX-1 cells (10<sup>5</sup> to 10<sup>7</sup> cells/ml) are removed from cultures and concentrated such as by centrifugation at 300 x g for 10 minutes. The supernatant is decanted and cells washed, in a suitable buffer. Preferably, cells are again concentrated, such as by centrifugation at 300 x g for 10 minutes and resuspended to a final cell density of approximately 1.5 x 10<sup>6</sup> cells/ml, preferably in prewarmed HBSS.

10 Following incubation of human osteosarcoma cells or COX-1 cells in a suitable buffer, test compound and/or vehicle samples (such as DMSO) are added, and the resulting composition gently mixed. Preferably the assay is performed in triplicate. The arachidonic acid is then added in proportions as described above. We prefer to incubate 15 the cells for approximately 5 minutes at 30 to 40°C, prior to the addition of the of peroxide-free arachidonic acid (CAYMAN) diluted in a suitable buffer such as HBSS. Control samples should contain ethanol or other vehicle instead of arachidonic acid. A total reaction incubation time of 5 to 10 minutes at to 37°C has proven satisfactory. 20 For osteosarcoma cells, reactions may be stopped by the addition HCl or other acid, preferably combined with mixing, or rapid removal of media directly from cell monolayers. For U-937 cells, reactions may be advantageously be performed in multiwell dishes or microcentrifuge tubes and stopped by the addition of HCl or other mineral acid. 25 Typically, samples assayed in 24-multidishes are then transferred to microcentrifuge tubes, and all samples frozen on dry ice. Similarly, samples are typically stored at -20°C or below prior to analysis of PGE<sub>2</sub> levels.

30 Quantitation of PGE<sub>2</sub> concentrations

Stored osteosarcoma 143 and U-937 samples are thawed, if frozen, and neutralized, if stored in acid. Samples are then preferably mixed, such as by vortexing, and PGE<sub>2</sub> levels measured using a PGE<sub>2</sub>

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enzyme immunoassay, such as is commercially available from CAYMAN. We have advantageously conducted the plating, washing and colour development steps as an automated sequence using a BIOMEK 1000 (BECKMAN). In our preferred procedure, following the addition of ELLMANS reagent, color development is monitored at 415 nm using the BIORAD model 3550 microplate reader with MICROPLATE MANAGER/PC DATA ANALYSIS software. Levels of PGE<sub>2</sub> are calculated from the standard curve, and may optionally determined using BECKMAN IMMUNOFIT EIA/RIA analysis software.

In the absence of the addition of exogenous arachidonic acid, levels of PGE<sub>2</sub> in samples from both human osteosarcoma cells and COX-1 cells are approximately typically 0.1 to 2.0 ng/10<sup>6</sup> cells. In the presence of arachidonic acid, levels of PGE<sub>2</sub> in samples from these cell lines increased to approximately 5 to 10 fold in osteosarcoma cells and 50 to 100 fold in COX-1 cells. For purposes of this specification, cellular cyclooxygenase activity in each cell line is defined as the difference between PGE<sub>2</sub> levels in samples incubated in the absence or presence of arachidonic acid, with the level of detection being approximately 10 pg/sample. Inhibition of PGE<sub>2</sub> synthesis by test compounds is calculated between PGE<sub>2</sub> levels in samples incubated in the absence or presence of arachidonic acid.

#### Microsomal cyclooxygenase assay

Human osteosarcoma cells may be grown and maintained in culture as described above. 10<sup>5</sup> to 10<sup>7</sup> cells are plated in tissue culture plates such as available from NUNCLON and maintained in culture for 2 to 7 days. Cells may be washed with a suitable buffer such phosphate buffered saline, pH 7.2, (PBS). Cells are then removed from the plate, preferably by scraping into PBS. Samples may then be concentrated, such as by centrifuging at 400 x g for 10 minutes at 4°C. Cell pellets or other concentrate are either stored at a suitable reduced temperature such as -80°C, or processed immediately. All further manipulations of the cells are preferably performed at 0-4°C. Cell pellets or concentrates

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obtained from two tissue culture plates are resuspended in a standard protective buffer, such as Tris-Cl, pH 7.4, containing 10 mM EDTA, 1 mM phenylmethylsulfonylfluoride, 2 µg/ml leupeptin, 2 µg/ml aprotinin, and 2 µg/ml soybean trypsin inhibitor and blended or homogenized, such as by sonication for three x 5 seconds using a 4710 series ultrasonic homogenizer (COLE-PARMER) set at 75% duty cycle, power level 3. Enriched microsomal preparations are then prepared, such as by differential centrifugation to yield an enriched microsomal preparation. In our preferred procedure, the first step consists of four sequential centrifugations of the cell homogenate at 10,000 x g for 10 min at 4°C. After each centrifugation at 10,000 x g the supernatant is retained and recentrifuged. Following the fourth centrifugation, the supernatant is centrifuged at 100,000 x g for 60-90 min at 4°C to pellet the microsomal fraction. The 100,000 x g supernatant is discarded and the 100,000 x g microsomal pellet is resuspended in a suitable buffer such as 0.1 M Tris-Cl, pH 7.4, containing 10 mM EDTA and 0.25 mg/ml delipidized bovine serum albumin (COLLABORATIVE RESEARCH INCORPORATED). The resulting microsomal suspension is recentrifuged such as at 100,000 x g for 90 min at 4°C to recover the microsomes. Following this centrifugation the microsomal pellet is resuspended in a stabilizing buffer, such as 0.1 M Tris-Cl, pH 7.4, containing 10 mM EDTA at a protein concentration of approximately 2-5 mg/ml. Aliquots of osteosarcoma microsomal preparations may be stored at low temperature, such as at -80°C and thawed prior to use.

As may be appreciated by those of skill in the art, Human or serum albumin or other albumin, may be used as an alternative to BSA. Applicants have found that while the procedure may be carried out using standard BSA or other albumin, delipidized BSA is preferred. In particular, by use of delipidized BSA, endogenous microsomal arachidonic acid can be reduced by a factor of 2 or greater, such that the arachidonic acid produced in the assay constituted at least 90% of the total. As may be appreciated by those of skill in the art, other lipid adsorbing or sequestering agents may also be used. For purposes of this specification microsomes from which the exogenous arachidonic acid

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has been reduced by a factor of approximately 2 or more shall be considered to be microsomes that are substantially free of exogenous arachidonic acid.

COX-1 cells are grown and maintained in culture as described above, washed in a suitable buffer, such as PBS, and cell pellets or concentrates stored, preferably at  $-80^{\circ}\text{C}$ . Cell pellets or concentrates corresponding to approximately  $10^9$  to  $10^{10}$  cells were resuspended in a suitable buffer, such as 10 ml of 0.1 M Tris-HCl, pH 7.4 and blended or homogenized, such as by sonication for 2 x 5 seconds and 1 x 10 seconds using a 4710 series ultrasonic homogenizer (COLE-PARMER) set at 75% duty cycle, power level 3. The cell homogenate is then concentrated and resuspended. In our preferred procedure the cell homogenate is centrifuged at  $10,000 \times g$  for 10 minutes at  $4^{\circ}\text{C}$ . The supernatant fraction is then recentrifuged at  $100,000 \times g$  for 2 hours at  $4^{\circ}\text{C}$ , and the resulting microsomal pellet resuspended in a suitable buffer, such as 0.1 M Tris-HCl, 1 mM EDTA, pH 7.4 to a protein concentration of approximately 1 to 10 mg/ml. Aliquots of osteosarcoma microsomal preparations may be stored at reduced temperature and thawed prior to use.

#### Assay procedure

Microsomal preparations from Human osteosarcoma and COX-1 cells are diluted in buffer, such as 0.1 M Tris-HCl, 10 mM EDTA, pH 7.4, (buffer A) to a protein concentration of 50 to 500  $\mu\text{g/ml}$ . 10 to 50  $\mu\text{l}$  of test compound or DMSO or other vehicle is added to 2 to 50  $\mu\text{l}$  of buffer A. 50 to 500  $\mu\text{l}$  of microsome suspension is then added, preferably followed by mixing and incubation for 5 minutes at room temperature. Typically, assays are performed in either duplicate or triplicate. Peroxide-free arachidonic acid (CAYMAN) in buffer A is then added to a final concentration of 20  $\mu\text{M}$  arachidonic acid, followed by incubation, preferably at room temperature for 10 to 60 minutes. Control samples contained ethanol or other vehicle instead of arachidonic acid. Following incubation, the reaction was terminated by addition of HCl or other mineral acid. Prior to analysis of PGE<sub>2</sub>

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levels, samples were neutralized. Levels of PGE<sub>2</sub> in samples may be quantitated as described for the whole cell cyclooxygenase assay.

Cyclooxygenase activity in the absence of test compounds was determined as the difference between PGE<sub>2</sub> levels in samples incubated in the presence of arachidonic acid or ethanol vehicle, and reported as ng of PGE<sub>2</sub>/mg protein. Inhibition of PGE<sub>2</sub> synthesis by test compounds is calculated between PGE<sub>2</sub> levels in samples incubated in the absence or presence of arachidonic acid.

### EXAMPLE 1

#### Whole cell cyclooxygenase assays

Human osteosarcoma 143.98.2 cells were cultured in DULBECCOS MODIFIED EAGLES MEDIUM (SIGMA) containing 3.7 g/l NaHCO<sub>3</sub> (SIGMA), 100 µg/l gentamicin (GIBCO), 25 mM HEPES, pH 7.4 (SIGMA), 100 IU/ml penicillin (FLOW LABS), 100 µg/ml streptomycin (FLOW LABS), 2 mM glutamine (FLOW LABS) and 10% fetal bovine serum (GIBCO). Cells were maintained at 37°C, 6% CO<sub>2</sub> in 150cm<sup>2</sup> tissue culture flasks (CORNING). For routine subculturing, media was removed from confluent cultures of cells, which were then incubated with 0.25% trypsin/0.1% EDTA (JRH BIOSCIENCES) and incubated at room temperature for approximately 5 minutes. The trypsin solution was then aspirated, and cells resuspended in fresh medium and dispensed at a ratio of 1:10 or 1:20 into new flasks.

U-937 cells (ATCC CRL 1593) were cultured in 89% RPMI-1640 (SIGMA), 10% fetal bovine serum (GIBCO), containing 50 IU/ml penicillin (Flow labs), 50 µg/ml streptomycin (FLOW LABS) and 2 g/l NaHCO<sub>3</sub> (SIGMA). Cells were maintained at a density of 0.1-2.0 x 10<sup>6</sup>/ml in 1 liter spinner flasks (Corning) at 37°C, 6% CO<sub>2</sub>. For routine subculturing, cells were diluted in fresh medium and transferred to fresh flasks.

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Assay Protocol

For cyclooxygenase assays, osteosarcoma 143.98.2 cells were cultured in 1 ml of media in 24-well multidishes (NUNC) until confluent. The number of cells per assay was determined from replicate plates prior to assays, using standard procedures. Immediately prior to cyclooxygenase assays, media was aspirated from cells, and the cells washed once with 2 ml of Hanks balanced salts solution (HBSS; SIGMA) prewarmed to 37°C. 1 ml of prewarmed HBSS was then added per well.

Immediately prior to cyclooxygenase assays, the appropriate number of U-937 cells were removed from spinner cultures and centrifuged at 300 x g for 10 minutes. The supernatant was decanted and cells washed in 50 ml of HBSS prewarmed to 37°C. Cells were again pelleted at 300 x g for 10 minutes and resuspended in prewarmed HBSS to a final cell density of approximately  $1.5 \times 10^6$  cells/ml. 1 ml aliquots of cell suspension were transferred to 1.5 ml microcentrifuge tubes or 24-well multidishes (Nunc).

Following washing and resuspension of osteosarcoma 143 and U-937 cells in 1 ml of HBSS, 1 µl of test compounds or DMSO vehicle were added, and samples gently mixed. All assays were performed in triplicate. Samples were then incubated for 5 minutes at 37°C, prior to the addition of 10 µl of peroxide-free arachidonic acid (CAYMAN) diluted to 1 µM in HBSS. Control samples contained ethanol vehicle instead of arachidonic acid. Samples were again gently mixed and incubated for a further 10 minutes at 37°C. For osteosarcoma cells, reactions were then stopped by the addition of 100 µl of 1N HCl, with mixing, or by the rapid removal of media directly from cell monolayers. For U-937 cells, reactions in multiwell dishes or microcentrifuge tubes were stopped by the addition of 100 µl of 1N HCl, with mixing. Samples assayed in 24-multidishes were then transferred to microcentrifuge tubes, and all samples were frozen on dry ice. Samples were stored at -20°C prior to analysis of PGE<sub>2</sub> levels.



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### Quantitation of PGE<sub>2</sub> Concentrations

Osteosarcoma 143.98.2 and U-937 samples were thawed, and 100 µl of 1N NaOH added to samples to which 1N HCl had been added prior to freezing. Samples were then mixed by vortexing, and PGE<sub>2</sub> levels measured using a PGE<sub>2</sub> enzyme immunoassay (CAYMAN) according to the manufacturers instructions. The plating, washing and colour development steps of this procedure were automated using a BIOMEK 1000 (BECKMAN). Following the addition of ELLMANS reagent, color development was monitored at 415 nm using the Biorad model 3550 microplate reader with microplate manager/PC data analysis software. Levels of PGE<sub>2</sub> were calculated from the standard curve determined using BECKMAN IMMUNOFTT EIA/RIA analysis software.

### Results

In the absence of the addition of exogenous arachidonic acid, levels of PGE<sub>2</sub> in samples from both osteosarcoma 143 cells and U-937 cells were generally 2ng/10<sup>6</sup> cells. In the presence of arachidonic acid, levels of PGE<sub>2</sub> in samples from these cell lines increased to approximately 5 to 10 fold in osteosarcoma cells and 50 to 100 fold in U-937 cells.

Table 1 show the effects of a series of non-steroidal antiinflammatory compounds on PGE<sub>2</sub> synthesis by human osteosarcoma 143 cells and U-937 cells in response to exogenous arachidonic acid.

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TABLE 1

5	SAMPLE	CONCENTRATION	osteosarcoma 143	U-937
			PGE2 ng/10 <sup>6</sup> cells	PGE2
	-AA	--	1.8	0.15
	AA, no inhibitor	--	8.6	17.7
	NS-389	100.0	0.8	18.9
		30.0	1.1	17.7
10		10.0	3.0	20.4
		3.0	2.7	18.3
		1.0	3.2	17.7
		0.3	8.3	18.3
15	ibuprofen	100,000	2.5	1.1
		10,000	5.7	5.5
		1,000	5.4	14.3
		300	10.8	15.8
		100	12.8	17.1
20		10	12.5	16.4

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EXAMPLE 2Microsomal cyclooxygenase assay

Osteosarcoma 143.98.2 cells were grown and maintained in culture as described above. 3 x 10<sup>6</sup> cells were plated in 245 x 245 x 20 mm tissue culture plates (NUNCCLON) and maintained in culture for 5 days. Cells were washed twice with 100 ml of phosphate buffered saline, pH 7.2, (PBS) and then scraped from the plate with a sterile rubber scraper into PBS. Samples were then centrifuged at 400 x g for 10 minutes at 4°C. Cell pellets were either stored at -80°C until use or processed immediately. All further manipulations of the cells were performed at 0-4°C. Cell pellets obtained from two tissue culture plates were resuspended in 5 ml of 0.1 M Tris-Cl, pH 7.4, containing 10 mM EDTA, 1 mM phenylmethylsulfonylfluoride, 2 µg/ml leupeptin, 2 µg/ml aprotinin, and 2 µg/ml soybean trypsin inhibitor and sonicated for three x 5 seconds using a 4710 series ultrasonic homogenizer (Cole-Parmer) set at 75% duty cycle, power level 3. The cell homogenates were then subjected to a differential centrifugation protocol to yield an enriched microsomal preparation. The first step consisted of four sequential centrifugations of the cell homogenate at 10,000 x g for 10 min at 4°C. After each centrifugation at 10,000 x g the supernatant was retained and recentrifuged. Following the fourth centrifugation, the supernatant was centrifuged at 100,000 x g for 60-90 min at 4°C to pellet the microsomal fraction. The 100,000 x g supernatant was discarded and the 100,000 x g microsomal pellet was resuspended in 8 mls of 0.1 M Tris-Cl, pH 7.4, containing 10 mM EDTA and 0.25 mg/ml delipidized bovine serum albumin (COLLABORATIVE RESEARCH INCORPORATED). The resulting microsomal suspension was recentrifuged at 100,000 x g for 90 min at 4°C to recover the microsomes. Following this centrifugation the microsomal pellet was resuspended in 0.1 M Tris-Cl, pH 7.4, containing 10 mM EDTA at a protein concentration of approximately 2-5 mg/ml. 500 µl aliquots of osteosarcoma microsomal preparations were stored at -80°C and thawed on ice immediately prior to use.

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U-937 cells were grown and maintained in culture as described above, washed in PBS, and cell pellets frozen at -80°C. Cell pellets corresponding to approximately  $4 \times 10^9$  cells were resuspended in 10 ml of 0.1 M Tris-HCl, pH 7.4 and sonicated for 2 x 5 seconds and 1 x 10 seconds using a 4710 series ultrasonic homogenizer (COLE-PARMER) set at 75% duty cycle, power level 3. The cell homogenate was then centrifuged at 10,000 x g for 10 minutes at 4°C. The supernatant fraction was then recentrifuged at 100,000 x g for 2 hours at 4°C, and the resulting microsomal pellet resuspended in 0.1 M Tris-HCl, 1 mM EDTA, pH 7.4 to a protein concentration of approximately 4 mg/ml. 500 µl aliquots of osteosarcoma microsomal preparations were stored at -80°C and thawed on ice immediately prior to use.

#### Assay Protocol

Microsomal preparations from osteosarcoma 143 and U-937 cells were diluted in 0.1 M Tris-HCl, 10 mM EDTA, pH 7.4, (buffer A) to a protein concentration of 100 µg/ml. All subsequent assay steps, including the dilution of stock solutions of test compounds, were automated using the BIOMEK 100 (BIORAD). 5 µl of test compound or DMSO vehicle was added, with mixing, to 20 µl of buffer A in a 96-well minitube plate (BECKMAN). 200 µl of microsome suspension was then added, followed by mixing and incubation for 5 minutes at room temperature. Assays were performed in either duplicate or triplicate. 25 µl of peroxide-free arachidonic acid (CAYMAN) in buffer A is then added to a final concentration of 20 µM arachidonic acid, with mixing, followed by incubation at room temperature for 40 minutes. Control samples contained ethanol vehicle instead of arachidonic acid. Following the incubation period, the reaction was terminated by the addition of 25 µl of 1N HCl, with mixing. Prior to analysis of PGE<sub>2</sub> levels, samples were neutralized by the addition of 25 µl of 1 N NaOH. Levels of PGE<sub>2</sub> in samples were quantitated by enzyme immunoassay (CAYMAN) as described for the whole cell cyclooxygenase assay.

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TABLE II

## MICROSOMAL ASSAY RESULTS - SET 1

		143.98.2	U-937
	<u>DRUG</u>	<u>%Inhibition</u>	<u>%Inhibition</u>
5	100 nM DuP-697	92	6
	3 uM "	93	48
	100 nM Flufenamic	16	5
	3 uM "	36	0
10	100 nM Flosulide	13	0
	3 uM "	57	0
	100 nM Zomipirac	45	30
	3 uM "	66	67
	100 nM NS-398	45	0
15	3 uM "	64	0
	100 nM Diclofenac	70	49
	3 uM "	86	58
	100 nM Sulindac sulfide	19	0
	3 uM "	33	4
20	100 nM FK-3311	20	0
	3 uM "	26	0
	100 nM Fluribprofen	55	57
	3 uM "	58	89

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EXAMPLE 3Reverse transcriptase/polymerase chain reaction

30 In order to confirm the type of cyclooxygenase mRNA present in osteosarcoma 143.98.2 cells, a reverse transcriptase polymerase chain reaction (RT-PCR) analytical technique was employed. Total RNA was prepared from osteosarcoma cells harvested 1-2 days after the cultures had reached confluence. The cell pellet was resuspended in 6 ml of 5 M guanidine monothiocyanate containing 10 mM EDTA, 50 mM Tris-Cl, pH 7.4, and 8 % (w/v)  $\beta$ -mercaptoethanol.

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The RNA was selectively precipitated by addition of 42 ml of 4 M LiCl, incubation of the solution for 16 h at 4°C, followed by recovery of the RNA by centrifugation at 10,000 x g for 90 min at 4°C. The RNA pellet which was obtained was resuspended in 10 mM Tris-HCl, pH 7.5, 1 mM EDTA, and 0.1% SDS at a concentration of 4 µg/ml and used directly for quantitation of COX-1 and COX-2 mRNAs by RT-PCR.

The quantitative RT-PCR technique employs pairs of synthetic oligonucleotides which will specifically amplify cDNA fragments from either COX-1, COX-2, or the control mRNA glyceraldehyde-3-phosphate-dehydrogenase (G3PDH). The synthetic oligonucleotides are described in Maier, Hla, and Maciag (J. Biol. Chem. 265: 10805-10808 (1990)); Hla and Maciag (J. Biol. Chem. 266: 24059-24063 (1991)); and Hla and Neilson (Proc. Natl. Acad. Sci., (USA) 89: 7384-7388 (1992)), and were synthesized according to the following sequences:

**Human COX-1 specific oligonucleotides**

5'-TGCCCAGCTCCTGGCCCGCCGCTT-3' SEQ. ID. NO:1:

5'-GTGCATCAACACAGGCGCCTCTTC-3' SEQ. ID. NO:2:

**Human COX-2 specific oligonucleotides**

5'-TTCAAATGAGATTGTGGGAAAATTGCT-3' SEQ. ID. NO:3:

5'-AGATCATCTCTGCCTGAGTATCTT-3' SEQ. ID. NO:4:

**Human glyceraldehyde-3-phosphate dehydrogenase specific oligonucleotides**

5'-CCACCCATGGCAAATTCCATGGCA-3' SEQ. ID. NO:5:

5'-TCTAGACGGCAGGTCAGGTCCACC-3' SEQ. ID. NO:6:

The RT-PCR reactions were carried out using a RT-PCR kit from CETUS-PERKIN ELMER according to the manufacturers instructions. Briefly, 4 µg of osteosarcoma total RNA was reverse transcribed to cDNA using reverse transcriptase and random hexamers as primers for 10 min at 23°C, 10 min at 42°C, followed by an

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incubation at 99°C for 5 min. The osteosarcoma cDNA sample was split into three equal aliquots which were amplified by PCR using 10 pmol of specific oligonucleotide pairs for either COX-1, COX-2, or G3PDH. The PCR cycling program was 94°C for 1 min, 55°C for 1 min, and 72°C for 1 min. After the twentieth, twenty-fifth, and thirtieth cycle an aliquot was removed from the reaction mixture and stopped by the addition of 5 mM EDTA. Control reactions included RT-PCR reactions which contained no RNA and also reactions containing RNA but no reverse transcriptase.

Following RT-PCR the reactions were electrophoresed through a 1.2 % agarose gel using a Tris-sodium acetate-EDTA buffer system at 110 volts. The positions of PCR-generated DNA fragments were determined by first staining the gel with ethidium bromide. The identity of the amplified DNA fragments as COX-1, COX-2, or G3PDH was confirmed by Southern blotting, using standard procedures. Nitrocellulose membranes were hybridized with radiolabelled COX-1, COX-2, or G3PDH-specific probes. Hybridization of the probes was detected by autoradiography and also by determining the bound radioactivity by cutting strips of the nitrocellulose which were then counted by liquid scintillation counting.

The RT-PCR/Southern hybridization experiment demonstrated that COX-2 mRNA is easily detected in osteosarcoma cell total RNA. No COX-1 cDNA fragment could be generated by PCR from osteosarcoma cell total RNA, although other mRNA species such as that for G3PDH are detected. These results demonstrate that at the sensitivity level of RT-PCR, osteosarcoma cells express COX-2 mRNA but not COX-1 mRNA.

#### Western blot of U-937 and 143.98.2 cell RNA

We have developed a rabbit polyclonal antipeptide antiserum (designated MF-169) to a thyroglobulin-conjugate of a peptide corresponding to amino acids 589-600, inclusive, of human cyclooxygenase-2. This amino acid sequence:

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Asp-Asp-Ile-Asn-Pro-Thr-Val-Leu-Leu-Lys-Glu-Arg.  
(also identified herein as SEQ. ID. NO:7:) has no similarity to any  
peptide sequence of human cyclooxygenase-1. At a dilution of 1:150,  
this antiserum detects by immunoblot a protein corresponding to the  
molecular weight of cyclooxygenase-2 in microsomal preparations from  
osteosarcoma 143 cells. The immunoblot procedure used for these  
studies has previously been described (Reid *et al.*, J. Biol. Chem. 265:  
19818-19823 (1990)). No band corresponding to the molecular weight  
of cyclooxygenase-2 is observed using a 1:150 dilution of pre-immune  
serum from the rabbit used to raise antiserum. Furthermore, a band  
corresponding to the molecular weight of cyclooxygenase-2 is observed  
by immunoblot in microsomal preparations of osteosarcoma 143 cells  
using a 1:150 dilution of a commercially available polyclonal antiserum  
against cyclooxygenase-2 (CAYMAN). This antiserum is reported to  
not cross-react with cyclooxygenase-1. These results clearly  
demonstrate that osteosarcoma 143 cells express cyclooxygenase-2.  
Furthermore, immunoblot analysis with these antisera and northern blot  
analysis using a COX-2-specific probe demonstrated that levels of  
cyclooxygenase-2 protein and the corresponding mRNA increase in  
osteosarcoma 143 cells as they grow past confluence. Within a 3-hour  
period, and in the presence of 1% serum, human recombinant IL1- $\alpha$   
(10 pg/ml; R and D systems Inc.) human recombinant IL1- $\beta$  (10 pg/ml;  
R and D systems Inc.), human EGF (15 ng/ml; CALBIOCHEM) and  
conditioned medium from cells grown beyond confluence also increased  
levels of PGE<sub>2</sub> synthesis by osteosarcoma 143 cells in response to  
arachidonic acid, relative to cells grown in the absence of these factors.

#### EXAMPLE 4

Identification by northern blot analysis of cell lines expressing either  
COX-1 or COX-2 exclusively

Northern blot analysis was used to determine that U-937  
cells express only COX-1 mRNA whereas osteosarcoma 143.98.2  
expresses only COX-2 mRNA. This was accomplished by first cloning  
human Cox-2 cDNA from total RNA of the human 143 osteosarcoma



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cell line. Total RNA was prepared from approximately 1X10<sup>8</sup> 143  
osteosarcoma cells using 4M guanidinium isothiocyanate (Maniatis, et al.  
(1982) Molecular Cloning, Cold Spring Harbor). Oligonucleotide  
primers corresponding to the 5' and 3' ends of the published Cox-2  
cDNA sequence (Hla and Neilson, (1992) Proc. Natl. Acad. Sci., USA  
89, 7384-7388) were prepared and are shown below.

HCOX-1 5'CTGCGATGCTCGCCCGCGCCCTG3' 5'Primer  
HCOX-2 5'CTTCTACAGTTCAGTCGAACGTTC3' 3'Primer

These primers (also identified hereinunder as SEQ. ID.  
NO:8: and SEQ. ID. NO:9: respectively) were used in a reverse  
transcriptase PCR reaction of 143 osteosarcoma total RNA. The  
reaction contained 1ug of 143 osteosarcoma total RNA, which was first  
reverse transcribed using random hexamers and reverse transcriptase  
(Maniatis, et al. (1982) Molecular Cloning, Cold Spring Harbor). The  
products from this reaction were then amplified using the HCOX-1 and  
HCOX-2 primers described above and Taq polymerase (Saiki, et al.  
(1988) Science, 239, 487-488). The conditions used for the  
amplification were 94°C for 30 sec, 55°C for 30 sec and 72°C for 2 min  
15 sec for 30 cycles. The amplified products were run on a 1% low  
melt agarose gel and the 1.9kb DNA fragment corresponding to the  
predicted size of human COX-2 cDNA was excised and recovered. An  
aliquot of the recovered COX-2 cDNA was reamplified as described  
above (no reverse transcriptase reaction), the amplified products were  
again run on a 1% low melt agarose gel and recovered.

By standard procedures as taught in Maniatis, et al. (1982)  
Molecular Cloning, Cold Spring Harbor, this 1.9kb DNA fragment was  
cloned into the Eco RV site of pBluescript KS (obtained from  
STRATAGENE) and transformed into competent DH5α bacteria  
(obtained from BRL) and colonies selected on LB agar/ampicillin  
overnight. Three clones giving the correct Pst I and Hinc II restriction  
digestions for human COX-2 cDNA were sequenced completely and

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verified to be correct. This was the first indication that the human 143 osteosarcoma cell line expressed COX-2 mRNA.

### Northern Analysis

5           Total RNA from various cell lines and tissues were prepared using the guanidinium isothiocyanate method as described above (Maniatis, et al. (1982) Molecular Cloning, Cold Spring Harbor). Poly A+ RNA was prepared using oligo dT cellulose spin columns (Maniatis, et al. (1982) Molecular Cloning, Cold Spring Harbor). The RNA, 10 µg of total or 5 µg of U937 Poly A+ were electrophoresed on 10 0.9% agarose 2.2 M formaldehyde gels (Maniatis, et al. (1982) Molecular Cloning, Cold Spring Harbor). After electrophoreses the gel was washed 3 times for 10 minutes each with distilled water and then two times for 30 minutes each in 10XSSC (1XSSC=0.15 M NaCl and 0.015 m sodium citrate). The RNA was transferred to nitrocellulose 15 using capillary transfer (Maniatis, et al. (1982) Molecular Cloning, Cold Spring Harbor) overnight in 10XSSC. The next day the filter was baked in a vacuum oven at 80°C for 1.5 hrs to fix the RNA onto the nitrocellulose. The filter was then equilibrated in pre-hybridization buffer (50% formamide, 6XSSC, 50 mM sodium phosphate buffer pH 20 6.5, 10 X Denhardts solution, 0.2% SDS and 250 µg/ml of sheared and denatured salmon sperm DNA) for approximately 4 hours at 40°C. The COX-2 cDNA probe was prepared using <sup>32</sup>P dCTP and random hexamer priming with T7 DNA polymerase using a commercial kit (Pharmacia). Hybridization was carried out using the same buffer as 25 for pre-hybridization plus 1-3x10<sup>6</sup> cpm/ml of denatured COX-2 cDNA probe at 40°C overnight. The blots were washed two times in 1xSSC and 0.5% SDS at 50°C for 30 minutes each, wrapped in saran wrap and exposed to Kodak XAR film with screen at -70°C for 1-3 days. The same blots were stripped of COX-2 probe by putting them in boiling 30 water and letting it cool to room temperature. The blot was re-exposed to film to ensure all hybridization signal was removed and then pre-hybridized and hybridized as described above using human COX-1 cDNA as probe. The human COX-1 cDNA was obtained from Dr.

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Colin Funk, Vanderbilt University, however the sequence is known in the art. See Funk, C.D., Funk, L.B., Kennedy, M.E., Pong, A.S., and Fitzgerald, G. A. (1991), FASEB J, 5 pp 2304-2312.

Using this Northern blot procedure applicants have established that the human 143 osteosarcoma cell line RNA hybridized only to the Cox-2 probe and not to the Cox-1 probe. The size of the hybridizing band obtained with the Cox-2 probe corresponded to the correct size of Cox-2 mRNA (approximately 4kb) suggesting that 143 osteosarcoma cells only express Cox-2 mRNA and no Cox-1 mRNA. This has been confirmed by RT-PCR as described above. Similarly, the human cell line U937 Poly A+ RNA hybridized only to the Cox-1 probe and not to the Cox-2 probe. The hybridizing signal corresponded to the correct size for Cox-1 mRNA (approximately 2.8kb) suggesting that U937 only express Cox-1 mRNA and not Cox-2. This was also confirmed by RT-PCR, since no product was obtained from U937 Poly A+ RNA when Cox-2 primers were used (see above).

### EXAMPLE 5

Human Cyclooxygenase-2 cDNA and Assays for Evaluating Cyclooxygenase-2 Activity Examples demonstrating expression of the Cox-2 cDNA

Comparison of the Cox-2 cDNA sequence obtained by RT-PCR of human osteosarcoma total RNA to the published sequence (Hla, Neilson 1992 Proc. Natl. Acad. Sci. USA, 89, 7384-7388), revealed a base change in the second position of codon 165. In the published sequence codon 165 is GGA, coding for the amino acid glycine, whereas in the osteosarcoma Cox-2 cDNA it is GAA coding for the amino acid glutamic acid.

To prove that osteosarcoma Cox-2 cDNA codes for glutamic acid at position 165 we repeated RT-PCR amplification of osteosarcoma Cox-2 mRNA; amplified, cloned and sequenced the region surrounding this base change from human genomic DNA; and used site directed mutagenesis to change Cox-2<sub>glu165</sub> to Cox-2<sub>gly165</sub> and compared there activities after transfection into COS-7 cells.

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1. RT-PCR of Cox-2 mRNA from Human Osteosarcoma total RNA.

5 A 300bp Cox-2 cDNA fragment that includes codon 165 was amplified by RT-PCR using human osteosarcoma 143 total RNA. Two primers:

Hcox-13 5'CCTTCCTTCGAAATGCAATTA3' SEQ. ID. NO: 12:  
Hcox-14 5'AAACTGATGCGTGAAGTGCTG3' SEQ. ID. NO: 13:

10 were prepared that spanned this region and were used in the PCR reaction. Briefly, cDNA was prepared from 1 µg of osteosarcoma 143 total RNA, using random priming and reverse transcriptase (Maniatis *et al.*, 1982, Molecular Cloning, Cold Spring Harbor). This cDNA was  
15 then used as a template for amplification using the Hcox-13 and Hcox-14 primers and Taq polymerase (Saki, *et al.* 1988, Science, 238, 487-488). The reaction conditions used were, 94°C for 30s, 52°C for 30s and 72°C for 30s, for 30 cycles. After electrophoresis of the reaction on a 2% low melt agarose gel, the expected 300 bp amplified product was  
20 obtained, excised from the gel and recovered from the agarose by melting, phenol extraction and ethanol precipitation. The 300 bp fragment was ligated into the TAI cloning vector (Invitrogen) and transformed into E. Coli (INVαF') (Invitrogen). Colonies were obtained and 5 clones were picked at random which contained the 300  
25 bp insert and sequenced. The sequence of codon 165 for all 5 clones was GAA (glutamic acid). Since the DNA sequence amplified was only 300 bp and the Taq polymerase has quite high fidelity for amplification of smaller fragments and its the second amplification reaction in which GAA was obtained for codon 165 confirms that Cox-2 mRNA from  
30 osteosarcoma has GAA for codon 165.

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2. Amplification of Cox-2 codon 165 region from genomic DNA.

To confirm that the osteosarcoma Cox-2 sequence was not an artefact of the osteosarcoma cell line and that this sequence was present in normal cells, the DNA sequences containing codon 165 was amplified from human genomic DNA prepared from normal blood. The primers used for the amplification reaction were Hcox-13 and Hcox-14. The genomic organization of the human Cox-2 gene has not yet been determined. Using mouse Cox-2 gene organization as a model for the exon-intron positioning of the human Cox-2 gene would place primer Hcox-13 in exon 3 and Hcox-14 in exon 5. The size of the amplified product would be around 2000 bp based on the mouse Cox-2 gene organization. The PCR reaction contained 1 µg of human genomic DNA, Hcox-13 and Hcox-14 primers and Taq polymerase. The reaction conditions used were 94°C for 30s, 52°C for 30s and 72°C for 45s, for 35 cycles. An aliquot of the reaction products was separated on a 1% low melt agarose gel. There were however a number of reaction products and to identify the correct fragment, the DNA was transferred to a nylon membrane by southern blotting and probed with a P-32 labelled human Cox-2 internal oligo.

Hcox-17 5'GAGATTGTGGGAAAATTGCTT3' SEQ. ID. NO: 14:

Hybridization was to a 1.4kb DNA fragment which was recovered from the remainder of the PCR reaction by electrophoresis on a 0.8% low melt agarose gel as described above. This fragment was ligated into the TAI cloning vector (Invitrogen) and used to transform bacteria (as described above). A clone containing this insert was recovered and sequenced. The sequence at codon 165 was GAA (glutamic acid) and this sequence was from the human Cox-2 gene since the coding region was interrupted by introns. (The 3' splice site of intron 4 in human is the same as the mouse). This is very convincing evidence of the existence of a human Cox-2 having glutamic acid at position 165.

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### 3. Cox-2glu165 vs Cox-2gly165 Activity in Transfected Cos-7 cells

To determine if Cox-2glu165 has cyclooxygenase activity and to compare its activity to Cox-2gly165, both cDNA sequences were cloned into the eukaryotic expression vector pcDNA-1 (Invitrogen) and transfected into COS-7 cells (see below). Activity was determined 48h after transfection by incubating the cells with 20  $\mu$ M arachidonic acid and measuring PGE<sub>2</sub> production by EIA (Cayman). The Cox-2gly165 sequence was obtained by site directed mutagenesis of Cox-2glu165. Briefly, single stranded KS+ plasmid (Stratagene) DNA containing the Cox-2glu165 sequence cloned into the Eco RV site of the multiple cloning region was prepared by adding 1 ml of an overnight bacterial culture (XL-1 Blue (Stratagene) containing the COX-2 plasmid) to 100 ml of LB ampicillin (100  $\mu$ g/ml) and grown at 37°C for 1 hr. One ml of helper phage, M13K07, (Pharmacia) was then added and the culture incubated for an additional 7 hrs. The bacteria was pelleted by centrifugation at 10,000 xg for 10 min, 1/4 volume of 20% PEG, 3.5M ammonium acetate was added to the supernatant and the phage precipitated overnight at 4°C. The single stranded phage were recovered the next day by centrifugation at 17,000 xg for 15 min, after an additional PEG precipitation the single stranded DNA was prepared from the phage by phenol and phenol:chloroform extractions and ethanol precipitation. The single stranded DNA containing the Cox-2glu165 sequence was used as template for site directed mutagenesis using the T7-GEN in vitro mutagenesis kit from U.S. Biochemical. The single stranded DNA (1.6 pmoles) was annealed to the phosphorylated oligo HCox-17 (16 pmoles), which changes codon 165 from GAA to GGA and the second strand synthesis carried out in the presence of 5-Methyl-dC plus the other standard deoxynucleoside triphosphates, T7 DNA polymerase and T4 DNA ligase. After synthesis the parental strand was nicked using the restriction endonuclease Msp 1 and then removed by exonuclease III digestion. The methylated mutated strand was rescued by transformation of E. coli mcAB-. Colonies were picked, sequenced

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and a number of clones were obtained that now had GGA for codon 165 instead of GAA. This Cox-2gly165 sequence was released from the bluescript KS vector by an Eco RI-Hind III digestion, recovered and cloned into the eukaryotic expression vector pcDNA-1 (Invitrogen) which had also been digested with Eco RI-Hind III. The Cox-2glu165  
5 sequence was also cloned into the pcDNA-1 vector in the exact same manner. The only difference between the two plasmids was the single base change in codon 165.

The COX-2 pcDNA-1 plasmids were used to transfect Cos-7 cells using a modified calcium phosphate procedure as described by  
10 Chen and Okyama (Chen, C.A. and Okyama, H. 1988. Biotechniques, 6, 632-638). Briefly,  $5 \times 10^5$  Cos-7 cells were plated in a 10 cm culture dish containing 10 ml media. The following day one hour before transfection the media was changed. The plasmid DNA (1-30  $\mu$ l) was mixed with 0.5 ml of 0.25 M  $\text{CaCl}_2$  and 0.5 ml of 2 x BBS (50  
15 mM N-, N-Bis(2-hydroxyethyl)-2-amino-ethanesulfonic acid, 280 mM NaCl, 1.5 mM  $\text{Na}_2\text{HPO}_4$ ) and incubated at room temperature for 20 min. The mixture was then added dropwise to the cells with swirling of the plate and incubated overnight (15-18 hrs) at 35°C in a 3%  $\text{CO}_2$  incubator. The next day the media was removed, the cells washed with  
20 PBS, 10 ml of fresh media added and the cells incubated for a further 48 hrs at 5%  $\text{CO}_2$ -37°C.

The cells were transfected with 2.5, 5 or 10  $\mu$ g of Cox-2glu165/pcDNA-1 or Cox-2gly165/pcDNA-1. Two plates were used for each DNA concentration and as a control the cells were transfected  
25 with pcDNA-1 plasmid. After 48h the media was removed from the cells, the plates washed 3X with Hank's media and then 2 ml of Hank's media containing 20  $\mu$ M arachadonic acid was added to the cells. After a 20 min incubation at 37°C the media was removed from the plate and the amount of PGE<sub>2</sub> released into the media was measured by EIA.  
30 The PGE<sub>2</sub> EIA was performed using a commercially available kit (Caymen) following the manufacturers instructions. Shown in Table III is the amount of PGE<sub>2</sub> released into the media from Cos-7 cells transfected with pcDNA-1, Cos-7 transfected with Cox-2glu165/pcDNA-

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1 and Cos-7 transfected with Cox-2gly165/pcDNA-1. Depending on the amount of DNA transfected into the Cos-7 cells, Cox-2glu165 is 1.3 to 2.3 times more active than Cox-2gly165.

Table III

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Level of PGE<sub>2</sub> pg/ml released from transfected Cos-7 cells

	<u>Amount of Transfected DNA (μg)</u>	<u>PGE<sub>2</sub> pg/ml</u>		
		2.5	5.0	10.0
10 Cos-7 + Cox-2glu165/pcDNA1		1120	2090	4020
Cos-7 + Cox-2gly165/pcDNA1		850	1280	1770
Cos-7 or Cos-7 + pcDNA1 (5 μg) <3.9 pg/ml PGE <sub>2</sub>				

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## SEQUENCE LISTING

## (1) GENERAL INFORMATION:

- 5 (i) APPLICANT: Kennedy, Brian P.  
Cromlish, Wanda A.  
Mancini, Joseph A.  
O'Neil, Gary  
Vickers, Philip J.  
Wong, Elizabeth
- (ii) TITLE OF INVENTION: HUMAN CYCLOOXYGENASE-2 cDNA AND  
ASSAY FOR EVALUATING CYCLOOXYGENASE ACTIVITY
- 10 (iii) NUMBER OF SEQUENCES: 11
- (iv) CORRESPONDENCE ADDRESS:  
(A) ADDRESSEE: Merck & Co., Inc.  
(B) STREET: 126 Lincoln Avenue  
(C) CITY: Rahway  
(D) STATE: NJ  
(E) COUNTRY: USA  
15 (F) ZIP: 07065
- (v) COMPUTER READABLE FORM:  
(A) MEDIUM TYPE: Diskette, 3.5 in, 1.4kb  
(B) COMPUTER: Apple Macintosh  
(C) OPERATING SYSTEM: System 7  
(D) SOFTWARE: Microsoft Word 5
- 20 (vi) CURRENT APPLICATION DATA:  
(A) APPLICATION NUMBER:  
(B) FILING DATE:  
(C) CLASSIFICATION:
- (viii) ATTORNEY/AGENT INFORMATION:  
(A) NAME: Panzer, Curtis C.  
(B) REGISTRATION NUMBER: 33,752  
(C) REFERENCE/DOCKET NUMBER: 189061A
- 25 (ix) TELECOMMUNICATION INFORMATION:  
(A) TELEPHONE: (908)594-3199  
(B) TELEFAX: (908)594-4720

## (2) INFORMATION FOR SEQ ID NO:1:

- 30 (i) SEQUENCE CHARACTERISTICS:  
(A) LENGTH: 24 bases  
(B) TYPE: nucleic acid  
(C) STRANDEDNESS: single  
(D) TOPOLOGY: linear
- (ii) MOLECULE TYPE: DNA (genomic)

- 32 -

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:1:

TGCCCAGCTC CTGGCCCGCC GCTT

24

(2) INFORMATION FOR SEQ ID NO:2:

5

(i) SEQUENCE CHARACTERISTICS:

(A) LENGTH: 24 bases

(B) TYPE: nucleic acid

(C) STRANDEDNESS: single

(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: DNA (genomic)

10

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:2:

GTGCATCAAC ACAGGCGCCT CTTC

24

(2) INFORMATION FOR SEQ ID NO:3:

15

(i) SEQUENCE CHARACTERISTICS:

(A) LENGTH: 27 bases

(B) TYPE: nucleic acid

(C) STRANDEDNESS: single

(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: DNA (genomic)

20

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:3:

TTCAAATGAG ATTGTGGGAA AATTGCT

27

(2) INFORMATION FOR SEQ ID NO:4:

25

(i) SEQUENCE CHARACTERISTICS:

(A) LENGTH: 24 bases

(B) TYPE: nucleic acid

(C) STRANDEDNESS: single

(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: DNA (genomic)

30

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:4:

AGATCATCTC TGCCTGAGTA TCTT

24

(2) INFORMATION FOR SEQ ID NO:5:

- 33 -

## (i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 24 bases
- (B) TYPE: nucleic acid
- (C) STRANDEDNESS: single
- (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: DNA (genomic)

5

## (xi) SEQUENCE DESCRIPTION: SEQ ID NO:5:

CCACCCATGG CAAATTCCAT GGCA

24

## (2) INFORMATION FOR SEQ ID NO:6:

10

## (i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 24 bases
- (B) TYPE: nucleic acid
- (C) STRANDEDNESS: single
- (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: DNA (genomic)

15

## (xi) SEQUENCE DESCRIPTION: SEQ ID NO:6:

TCTAGACGGC AGGTCAGGTC CACC

24

## (2) INFORMATION FOR SEQ ID NO:7:

20

## (i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 12 amino acids
- (B) TYPE: amino acid
- (C) STRANDEDNESS: single
- (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: protein

25

## (xi) SEQUENCE DESCRIPTION: SEQ ID NO:7:

Asp	Asp	Ile	Asn	Pro	Thr	Val	Leu	Leu	Lys	Glu	Arg
1				5					10		

## (2) INFORMATION FOR SEQ ID NO:8:

30

## (i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 23 bases
- (C) STRANDEDNESS: single
- (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: DNA (genomic)

- 34 -

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:8:

CTGCGATGCT CGCCGCGCC CTG

23

(2) INFORMATION FOR SEQ ID NO:9:

5

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 24 bases
- (B) TYPE: nucleic acid
- (C) STRANDEDNESS: single
- (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: DNA (genomic)

10

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:9:

CTTCTACAGT TCAGTCGAAC GTTC

24

(2) INFORMATION FOR SEQ ID NO:10:

15

(i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 604 amino acids
- (B) TYPE: amino acid
- (C) STRANDEDNESS: single
- (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: protein

20

(xi) SEQUENCE DESCRIPTION: SEQ ID NO:10:

Met Leu Ala Arg Ala Leu Leu Leu Cys Ala Val Leu Ala Leu Ser His  
1 5 10 15

25

Thr Ala Asn Pro Cys Cys Ser His Pro Cys Gln Asn Arg Gly Val Cys  
20 25 30

Met Ser Val Gly Phe Asp Gln Tyr Lys Cys Asp Cys Thr Arg Thr Gly  
35 40 45

Phe Tyr Gly Glu Asn Cys Ser Thr Pro Glu Phe Leu Thr Arg Ile Lys  
50 55 60

30

Leu Phe Leu Lys Pro Thr Pro Asn Thr Val His Tyr Ile Leu Thr His  
65 70 75 80

Phe Lys Gly Phe Trp Asn Val Val Asn Asn Ile Pro Phe Leu Arg Asn  
85 90 95

Ala Ile Met Ser Tyr Val Leu Thr Ser Arg Ser His Leu Ile Asp Ser  
100 105 110

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Pro Pro Thr Tyr Asn Ala Asp Tyr Gly Tyr Lys Ser Trp Glu Ala Phe  
 115 120 125  
 Ser Asn Leu Ser Tyr Tyr Thr Arg Ala Leu Pro Pro Val Pro Asp Asp  
 130 135 140  
 5 Cys Pro Thr Pro Leu Gly Val Lys Gly Lys Lys Gln Leu Pro Asp Ser  
 145 150 155 160  
 Asn Glu Ile Val Glu Lys Leu Leu Leu Arg Arg Lys Phe Ile Pro Asp  
 165 170 175  
 Pro Gln Gly Ser Asn Met Met Phe Ala Phe Phe Ala Gln His Phe Thr  
 180 185 190  
 10 His Gln Phe Phe Lys Thr Asp His Lys Arg Gly Pro Ala Phe Thr Asn  
 195 200 205  
 Gly Leu Gly His Gly Val Asp Leu Asn His Ile Tyr Gly Glu Thr Leu  
 210 215 220  
 Ala Arg Gln Arg Lys Leu Arg Leu Phe Lys Asp Gly Lys Met Lys Tyr  
 225 230 235 240  
 15 Gln Ile Ile Asp Gly Glu Met Tyr Pro Pro Thr Val Lys Asp Thr Gln  
 245 250 255  
 Ala Glu Met Ile Tyr Pro Pro Gln Val Pro Glu His Leu Arg Phe Ala  
 260 265 270  
 20 Val Gly Gln Glu Val Phe Gly Leu Val Pro Gly Leu Met Met Tyr Ala  
 275 280 285  
 Thr Ile Trp Leu Arg Glu His Asn Arg Val Cys Asp Val Leu Lys Gln  
 290 295 300  
 Glu His Pro Glu Trp Gly Asp Glu Gln Leu Phe Gln Thr Ser Arg Leu  
 305 310 315 320  
 25 Ile Leu Ile Gly Glu Thr Ile Lys Ile Val Ile Glu Asp Tyr Val Gln  
 325 330 335  
 His Leu Ser Gly Tyr His Phe Lys Leu Lys Phe Asp Pro Glu Leu Leu  
 340 345 350  
 Phe Asn Lys Gln Phe Gln Tyr Gln Asn Arg Ile Ala Ala Glu Phe Asn  
 355 360 365  
 30 Thr Leu Tyr His Trp His Pro Leu Leu Pro Asp Thr Phe Gln Ile His  
 370 375 380  
 Asp Gln Lys Tyr Asn Tyr Gln Gln Phe Ile Tyr Asn Asn Ser Ile Leu  
 385 390 395 400  
 Leu Glu His Gly Ile Thr Gln Phe Val Glu Ser Phe Thr Arg Gln Ile

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	405	410	415
	Ala Gly Arg Val Ala Gly Gly Arg Asn Val Pro Pro Ala Val Gln Lys		
	420	425	430
	Val Ser Gln Ala Ser Ile Asp Gln Ser Arg Gln Met Lys Tyr Gln Ser		
	435	440	445
5	Phe Asn Glu Tyr Arg Lys Arg Phe Met Leu Lys Pro Tyr Glu Ser Phe		
	450	455	460
	Glu Glu Leu Thr Gly Glu Lys Glu Met Ser Ala Glu Leu Glu Ala Leu		
	465	470	475
	Tyr Gly Asp Ile Asp Ala Val Glu Leu Tyr Pro Ala Leu Leu Val Glu		
	485	490	495
10	Lys Pro Arg Pro Asp Ala Ile Phe Gly Glu Thr Met Val Glu Val Gly		
	500	505	510
	Ala Pro Phe Ser Leu Lys Gly Leu Met Gly Asn Val Ile Cys Ser Pro		
	515	520	525
15	Ala Tyr Trp Lys Pro Ser Thr Phe Gly Gly Glu Val Gly Phe Gln Ile		
	530	535	540
	Ile Asn Thr Ala Ser Ile Gln Ser Leu Ile Cys Asn Asn Val Lys Gly		
	545	550	555
	Cys Pro Phe Thr Ser Phe Ser Val Pro Asp Pro Glu Leu Ile Lys Thr		
	565	570	575
20	Val Thr Ile Asn Ala Ser Ser Ser Arg Ser Gly Leu Asp Asp Ile Asn		
	580	585	590
	Pro Thr Val Leu Leu Lys Glu Arg Ser Thr Glu Leu		
	595	600	

## (2) INFORMATION FOR SEQ ID NO:11:

## 25 (i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 3387 bases
- (B) TYPE: nucleic acid
- (C) STRANDEDNESS: single
- (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: DNA (genomic)

30

## (xi) SEQUENCE DESCRIPTION: SEQ ID NO:11:

GTCCAGGAAC TCCTCAGCAG CGCCTCCTTC AGCTCCACAG CCAGACGCCC TCAGACAGCA	60
AAGCCTACCC CCGCGCCGCG CCCTGCCCCG CGCTGCGATG CTCGCCCCGCG CCCTGCTGCT	120

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	GTGCGCGGTC	CTGGCGCTCA	GCCATACAGC	AAATCCTTGC	TGTTCCCACC	CATGTCAAAA	180
	CCGAGGTGTA	TGTATGAGTG	TGGGATTTGA	CCAGTATAAG	TGCGATTGTA	CCCGGACAGG	240
	ATTCTATGGA	GAAAAC TGCT	CAACACCGGA	ATTTTTGACA	AGAATAAAAT	TATTTCTGAA	300
	ACCCACTCCA	AACACAGTGC	ACTACATACT	TACCCACTTC	AAGGGATTTT	GGAACGTTGT	360
5	GAATAACATT	CCCTTCCTTC	GAAATGCAAT	TATGAGTTAT	GTGTTGACAT	CCAGATCACA	420
	TTTGATTGAC	AGTCCACCAA	CTTACAATGC	TGACTATGGC	TACAAAAGCT	GGGAAGCCTT	480
	CTCTAACCTC	TCCTATTATA	CTAGAGCCCT	TCCTCCTGTG	CCTGATGATT	GCCCGACTCC	540
	CTTGGGTGTC	AAAGGTAAAA	AGCAGCTTCC	TGATTCAAAT	GAGATTGTGG	AAAAATTGCT	600
10	TCTAAGAAGA	AAGTTCATCC	CTGATCCCCA	GGGCTCAAAC	ATGATGTTTG	CATTCTTTGC	660
	CCAGCACTTC	ACGCACCAGT	TTTTCAAGAC	AGATCATAAG	CGAGGGCCAG	CTTTCACCAA	720
	CGGGCTGGGC	CATGGGGTGG	ACTTAAATCA	TATTTACGGT	GAAACTCTGG	CTAGACAGCG	780
	TAAACTGCGC	CTTTTCAAGG	ATGGAAAAAT	GAAATATCAG	ATAATTGATG	GAGAGATGTA	840
15	TCCTCCCACA	GTCAAAGATA	CTCAGGCAGA	GATGATCTAC	CCTCCTCAAG	TCCCTGAGCA	900
	TCTACGGTTT	GCTGTGGGGC	AGGAGGTCTT	TGGTCTGGTG	CCTGGTCTGA	TGATGTATGC	960
	CACAACTCTGG	CTGCGGGAAC	ACAACAGAGT	ATGTGATGTG	CTTAAACAGG	AGCATCCTGA	1020
	ATGGGGTGAT	GAGCAGTTGT	TCCAGACAAG	CAGGCTAATA	CTGATAGGAG	AGACTATTAA	1080
20	GATTGTGATT	GAAGATTATG	TGCAACACTT	GAGTGGCTAT	CACTTCAAAC	TGAAATTTGA	1140
	CCCAGAACTA	CTTTTCAACA	AACAATTCCA	GTACCAAAAT	CGTATTGCTG	CTGAATTTAA	1200
	CACCCCTCTAT	CACTGGCATC	CCCTTCTGCC	TGACACCTTT	CAAATTCATG	ACCAGAAATA	1260
	CAACTATCAA	CAGTTTATCT	ACAACAAC TC	TATATTGCTG	GAACATGGAA	TTACCCAGTT	1320
25	TGTTGAATCA	TTCACCAGGC	AAATTGCTGG	CAGGGTTGCT	GGTGGTAGGA	ATGTTCCACC	1380
	CGCAGTACAG	AAAGTATCAC	AGGCTTCCAT	TGACCAGAGC	AGGCAGATGA	AATACCAGTC	1440
	TTTTAATGAG	TACCGCAAAC	GCTTTATGCT	GAAGCCCTAT	GAATCATTTG	AAGAACTTAC	1500
	AGGAGAAAAG	GAAATGTCTG	CAGAGTTGGA	AGCACTCTAT	GGTGACATCG	ATGCTGTGGA	1560
30	GCTGTATCCT	GCCCTTCTGG	TAGAAAAGCC	TCGGCCAGAT	GCCATCTTTG	GTGAAACCAT	1620
	GGTAGAAGTT	GGAGCACCAT	TCTCCTTGAA	AGGACTTATG	GGTAATGTTA	TATGTTCTCC	1680
	TGCCTACTGG	AAGCCAAGCA	CTTTTGGTGG	AGAAGTGGGT	TTTCAAATCA	TCAACACTGC	1740
	CTCAATTCAG	TCTCTCATCT	GCAATAACGT	GAAGGGCTGT	CCCTTTACTT	CATTCACTGT	1800

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	TCCAGATCCA	GAGCTCATTA	AAACAGTCAC	CATCAATGCA	AGTTCTTCCC	GCTCCGGACT	1860
	AGATGATATC	AATCCACAG	TACTACTAAA	AGAACGGTCG	ACTGAACTGT	AGAAGTCTAA	1920
	TGATCATATT	TATTTATTTA	TATGAACCAT	GTCTATTAAT	TTAATTATTT	AATAATATTT	1980
	ATATTAAACT	CCTTATGTTA	CTTAACATCT	TCTGTAACAG	AAGTCAGTAC	TCCTGTTGCG	2040
5	GAGAAAGGAG	TCATACTTGT	GAAGACTTTT	ATGTCACTAC	TCTAAAGATT	TTGCTGTTGC	2100
	TGTTAAGTTT	GGAAAACAGT	TTTTATTCTG	TTTTATAAAC	CAGAGAGAAA	TGAGTTTTGA	2160
	CGTCTTTTTA	CTTGAATTTT	AACTTATATT	ATAAGGACGA	AAGTAAAGAT	GTTTGAATAC	2220
	TTAAACACTA	TCACAAGATG	CCAAAATGCT	GAAAGTTTTT	ACACTGTCTG	TGTTTCCAAT	2280
10	GCATCTTCCA	TGATGCATTA	GAAGTAACTA	ATGTTTGAAA	TTTTAAAGTA	CTTTTGGGTA	2340
	TTTTTCTGTC	ATCAAACAAA	ACAGGTATCA	GTGCATTATT	AAATGAATAT	TTAAATTAGA	2400
	CATTACCAGT	AATTTTCATG	CTACTTTTTA	AAATCAGCAA	TGAAACAATA	ATTTGAAATT	2460
	TCTAAATTCA	TAGGGTAGAA	TCACCTGTAA	AAGCTTGTTT	GATTTCTTAA	AGTTATTAAA	2520
15	CTTGACATA	TACCAAAAAG	AAGCTGTCTT	GGATTTAAAT	CTGTAAAATC	AGATGAAATT	2580
	TTACTACAAT	TGCTTGTTAA	AATATTTTAT	AAGTGATGTT	CCTTTTTTAC	CAAGAGTATA	2640
	AACCTTTTTA	GTGTGACTGT	TAAAACTTCC	TTTTAAATCA	AAATGCCAAA	TTTATTAAGG	2700
	TGGTGGAGCC	ACTGCAGTGT	TATCTCAAAA	TAAGAATATC	CTGTTGAGAT	ATTCCAGAAT	2760
20	CTGTTTATAT	GGCTGGTAAC	ATGTAAAAAC	CCCATAACCC	CGCCAAAAGG	GGTCCCTACCC	2820
	TTGAACATAA	AGCAATAACC	AAAGGAGAAA	AGCCCAAATT	ATTGGTTCCA	AATTTAGGGT	2880
	TTAAACTTTT	TGAAGCAAAC	TTTTTTTTTAG	CCTTGTGCAC	TGCAGACCTG	GTAATCAGAT	2940
	TTTGCTATGA	GGTTAATGAA	GTACCAAGCT	GTGCTTGAAT	AACGATATGT	TTTCTCAGAT	3000
25	TTTCTGTTGT	ACAGTTTAAT	TTAGCAGTCC	ATATCACATT	GCAAAAGTAG	CAATGACCTC	3060
	ATAAAATACC	TCTTCAAAAAT	GCTTAAATTC	ATTTACACAC	TTAATTTTAT	CTCAGTCTTG	3120
	AAGCCAATTC	AGTAGGTGCA	TTGGAATCAA	GCCTGGCTAC	CTGCATGCTG	TTCCTTTTCT	3180
	TTTCTTCTTT	TAGCCATTTT	GCTAAGAGAC	ACAGTCTTCT	CAAACACTTC	GTTTCTCCTA	3240
30	TTTTGTTTTA	CTAGTTTTAA	GATCAGAGTT	CACTTTCTTT	GGACTCTGCC	TATATTTTCT	3300
	TACCTGAACT	TTTGCAAGTT	TTCAGGTAAA	CCTCAGCTCA	GGACTGCTAT	TTAGCTCCTC	3360
	TTAAGAAGAT	TAAAAAAAAA	AAAAAAG				3387

(2) INFORMATION FOR SEQ ID NO:12:

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## (i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 21 bases
- (B) TYPE: nucleic acid
- (C) STRANDEDNESS: single
- (D) TOPOLOGY: linear

5 (ii) MOLECULE TYPE: DNA (genomic)

## (xi) SEQUENCE DESCRIPTION: SEQ ID NO:12:

CCTTCCTTCG AAATGCAATT A

21

10 (2) INFORMATION FOR SEQ ID NO:13:

## (i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 21 bases
- (B) TYPE: nucleic acid
- (C) STRANDEDNESS: single
- (D) TOPOLOGY: linear

15 (ii) MOLECULE TYPE: DNA (genomic)

## (xi) SEQUENCE DESCRIPTION: SEQ ID NO:13:

AAACTGATGC GTGAAGTGCT G

21

20 (2) INFORMATION FOR SEQ ID NO:14:

## (i) SEQUENCE CHARACTERISTICS:

- (A) LENGTH: 21 bases
- (B) TYPE: nucleic acid
- (C) STRANDEDNESS: single
- (D) TOPOLOGY: linear

25 (ii) MOLECULE TYPE: DNA (genomic)

## (xi) SEQUENCE DESCRIPTION: SEQ ID NO:14:

GAGATTGTGG GAAAATTGCT T

21

30

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WHAT IS CLAIMED IS:

1. An assay for determining the cyclooxygenase-2 activity of a sample comprising the steps of:
  - 5 (a) adding
    - (1) a human osteosarcoma cell preparation,
    - (2) a sample, said sample comprising a putative cyclooxygenase-2 inhibitor, and
    - (3) arachidonic acid; and
  - 10 (b) determining the amount of prostaglandin E<sub>2</sub> produced in step (a).
2. An assay according to Claim 1 wherein the cellular portion of the osteosarcoma cell preparation consists essentially of whole cells of osteosarcoma 143.98.2.
- 15 3. An assay according to Claim 1 wherein the cellular portion of the osteosarcoma cell preparation consists essentially of osteosarcoma 143.98.2 microsomes.
- 20 4. An assay according to Claim 3 wherein the microsomes are substantially free of endogenous arachidonic acid.
5. An assay according to Claim 3 wherein the microsomes are contacted with an amount of delipidized serum protein effective to reduce the amount of endogenous arachidonic acid in the microsomes by a factor of at least approximately 2.
- 25 6. An assay for determining the cyclooxygenase-2 activity of a sample according to Claim 1 comprising the steps of:
  - 30 (a) adding
    - (1) a human osteosarcoma cell preparation,
    - (2) a sample, said sample comprising a putative cyclooxygenase-2 inhibitor, and

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- (3) arachidonic acid; and  
(b) determining the amount of prostaglandin E<sub>2</sub> produced in step (a),  
wherein the cell preparation comprises 10<sup>3</sup> to 10<sup>9</sup> whole cells of osteosarcoma per cc, or 50 to 500 ug of osteosarcoma microsomes per ml of preparation; and 0.1 to 50 µl of arachidonic acid per ml of preparation.

7. A composition comprising:

- (a) an osteosarcoma cell preparation, having 10<sup>3</sup> to 10<sup>9</sup> osteosarcoma cells per cc of cell preparation or 50 to 500 µg of osteosarcoma microsomes; and  
(b) 0.1 to 50 µl of arachidonic acid per cc of cell preparation.

8. A composition according to Claim 5 comprising 8x10<sup>4</sup> to 2x10<sup>6</sup> osteosarcoma 143.98.2 whole cells per cc of cell preparation or 100 to 400 µg of osteosarcoma 143.98.2 microsomes; and 10 to 20 µl of peroxide-free arachidonic acid per cc of cell preparation.

9. A composition according to Claim 8 wherein the microsomes are substantially free of endogenous arachidonic acid.

10. An assay for determining the cyclooxygenase-1 activity of a sample comprising the steps of:

- (1) a COX-1 cell preparation,  
(2) a sample, said sample comprising a putative cyclooxygenase-1 inhibitor;  
(3) arachidonic acid; and  
(b) determining the amount of prostaglandin E<sub>2</sub> produced in step (a).

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11. An assay according to Claim 10 wherein the cellular portion of the COX-1 cell preparation consists essentially of whole cells of U-937.

5 12. An assay according to Claim 10 wherein the cellular portion of the COX-1 cell preparation consists essentially of U-937 microsomes.

10 13. An assay for determining the cyclooxygenase-1 activity of a sample according to Claim 10 comprising the steps of:  
(1) a COX-1 cell preparation,  
(2) a sample, said sample comprising a putative cyclooxygenase-1 inhibitor;  
(3) arachidonic acid; and  
15 (b) determining the amount of prostaglandin E<sub>2</sub> produced in step (a),  
wherein the cell preparation comprises  $10^5$  to  $10^8$  whole cells of U-937 per cc, or 1 to 10 mg of U-937 microsomes per ml of preparation; and  
20 0.1 to 50  $\mu$ l of arachidonic acid per ml of preparation.

14. An assay according to Claim 13 wherein the cell preparation comprises  $8 \times 10^5$  to  $1.5 \times 10^6$  whole cells of U-937 per cc, or 1 to 5 mg of U-937 microsomes per ml of preparation.

25 15. Human Cyclooxygenase-2 cDNA which is shown in Figure 2 or a degenerate variation thereof.

30 16. Human cyclooxygenase-2 cDNA according to Claim 12 comprising the coding region which is bases 97 to 1909 of Figure 2.

17. Human cyclooxygenase-2 which is shown in Figure 1.

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18. A system for stable expression of cyclooxygenase-2 as shown in Figure 1 comprising:

- (a) a mammalian or eukaryotic expression vector; and
- (b) a base sequence encoding human cyclooxygenase-2 comprising bases 97 to 1909 as shown in Figure 2 or a degenerate variation thereof.

19. A system according to Claim 18 wherein the expression vector is a vaccinia or baculovirus vector.

20. A system according to Claim 18 wherein cyclooxygenase-2 is expressed in COS-7 cells.

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Met	Leu	Ala	Arg	Ala	Leu	Leu	Leu	Cys	Ala	Val	Leu	Ala	Leu	Ser	His	1	5	10	15
Thr	Ala	Asn	Pro	Cys	Cys	Ser	His	Pro	Cys	Gln	Asn	Arg	Gly	Val	Cys	20	25	30	
Met	Ser	Val	Gly	Phe	Asp	Gln	Tyr	Lys	Cys	Asp	Cys	Thr	Arg	Thr	Gly	35	40	45	
Phe	Tyr	Gly	Glu	Asn	Cys	Ser	Thr	Pro	Glu	Phe	Leu	Thr	Arg	Ile	Lys	50	55	60	
Leu	Phe	Leu	Lys	Pro	Thr	Pro	Asn	Thr	Val	His	Tyr	Ile	Leu	Thr	His	65	70	75	80
Phe	Lys	Gly	Phe	Trp	Asn	Val	Val	Asn	Asn	Ile	Pro	Phe	Leu	Arg	Asn	85	90	95	
Ala	Ile	Met	Ser	Tyr	Val	Leu	Thr	Ser	Arg	Ser	His	Leu	Ile	Asp	Ser	100	105	110	
Pro	Pro	Thr	Tyr	Asn	Ala	Asp	Tyr	Gly	Tyr	Lys	Ser	Trp	Glu	Ala	Phe	115	120	125	
Ser	Asn	Leu	Ser	Tyr	Tyr	Thr	Arg	Ala	Leu	Pro	Pro	Val	Pro	Asp	Asp	130	135	140	
Cys	Pro	Thr	Pro	Leu	Gly	Val	Lys	Gly	Lys	Lys	Gln	Leu	Pro	Asp	Ser	145	150	155	160
Asn	Glu	Ile	Val	Glu	Lys	Leu	Leu	Leu	Arg	Arg	Lys	Phe	Ile	Pro	Asp	165	170	175	
Pro	Gln	Gly	Ser	Asn	Met	Met	Phe	Ala	Phe	Phe	Ala	Gln	His	Phe	Thr	180	185	190	
His	Gln	Phe	Phe	Lys	Thr	Asp	His	Lys	Arg	Gly	Pro	Ala	Phe	Thr	Asn	195	200	205	
Gly	Leu	Gly	His	Gly	Val	Asp	Leu	Asn	His	Ile	Tyr	Gly	Glu	Thr	Leu	210	215	220	
Ala	Arg	Gln	Arg	Lys	Leu	Arg	Leu	Phe	Lys	Asp	Gly	Lys	Met	Lys	Tyr	225	230	235	240

FIG. 1A

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Gln Ile Ile Asp Gly Glu Met Tyr Pro Pro Thr Val Lys Asp Thr Gln  
 245 250 255  
 Ala Glu Met Ile Tyr Pro Pro Gln Val Pro Glu His Leu Arg Phe Ala  
 260 265 270  
 Val Gly Gln Glu Val Phe Gly Leu Val Pro Gly Leu Met Met Tyr Ala  
 275 280 285  
 Thr Ile Trp Leu Arg Glu His Asn Arg Val Cys Asp Val Leu Lys Gln  
 290 295 300  
 Glu His Pro Glu Trp Gly Asp Glu Gln Leu Phe Gln Thr Ser Arg Leu  
 305 310 315 320  
 Ile Leu Ile Gly Glu Thr Ile Lys Ile Val Ile Glu Asp Tyr Val Gln  
 325 330 335  
 His Leu Ser Gly Tyr His Phe Lys Leu Lys Phe Asp Pro Glu Leu Leu  
 340 345 350  
 Phe Asn Lys Gln Phe Gln Tyr Gln Asn Arg Ile Ala Ala Glu Phe Asn  
 355 360 365  
 Thr Leu Tyr His Trp His Pro Leu Leu Pro Asp Thr Phe Gln Ile His  
 370 375 380  
 Asp Gln Lys Tyr Asn Tyr Gln Gln Phe Ile Tyr Asn Asn Ser Ile Leu  
 385 390 395 400  
 Leu Glu His Gly Ile Thr Gln Phe Val Glu Ser Phe Thr Arg Gln Ile  
 405 410 415  
 Ala Gly Arg Val Ala Gly Gly Arg Asn Val Pro Pro Ala Val Gln Lys  
 420 425 430  
 Val Ser Gln Ala Ser Ile Asp Gln Ser Arg Gln Met Lys Tyr Gln Ser  
 435 440 445  
 Phe Asn Glu Tyr Arg Lys Arg Phe Met Leu Lys Pro Tyr Glu Ser Phe  
 450 455 460

**FIG.1B**  
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Glu	Glu	Leu	Thr	Gly	Glu	Lys	Glu	Met	Ser	Ala	Glu	Leu	Glu	Ala	Leu	465	470	475	480
Tyr	Gly	Asp	Ile	Asp	Ala	Val	Glu	Leu	Tyr	Pro	Ala	Leu	Leu	Val	Glu	485	490	495	
Lys	Pro	Arg	Pro	Asp	Ala	Ile	Phe	Gly	Glu	Thr	Met	Val	Glu	Val	Gly	500	505	510	
Ala	Pro	Phe	Ser	Leu	Lys	Gly	Leu	Met	Gly	Asn	Val	Ile	Cys	Ser	Pro	515	520	525	
Ala	Tyr	Trp	Lys	Pro	Ser	Thr	Phe	Gly	Gly	Glu	Val	Gly	Phe	Gln	Ile	530	535	540	
Ile	Asn	Thr	Ala	Ser	Ile	Gln	Ser	Leu	Ile	Cys	Asn	Asn	Val	Lys	Gly	545	550	555	560
Cys	Pro	Phe	Thr	Ser	Phe	Ser	Val	Pro	Asp	Pro	Glu	Leu	Ile	Lys	Thr	565	570	575	
Val	Thr	Ile	Asn	Ala	Ser	Ser	Ser	Arg	Ser	Gly	Leu	Asp	Asp	Ile	Asn	580	585	590	
Pro	Thr	Val	Ile	Leu	Lys	Glu	Arg	Ser	Thr	Glu	Leu					595	600		

FIG.1C



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GTCCAGGAAC TCCTCAGCAG CGCCTCCTTC AGCTCCACAG CCAGACGCCC TCAGACAGCA	60
AAGCCTACCC CCGCGCCGCG CCCTGCCCCG CGCTGCGATG CTCGCCCGCG CCCTGCTGCT	120
GTGCGCGGTC CTGGCGCTCA GCCATACAGC AAATCCTTGC TGTTCACACC CATGTCAAAA	180
CCGAGGTGTA TGTATGAGTG TGGGATTGTA CCAGTATAAG TGCGATTGTA CCCGGACAGG	240
ATTCTATGGA GAAAACGCT CAACACCGGA ATTTTGTACA AGAATAAAAT TATTTCTGAA	300
ACCCACTCCA AACACAGTGC ACTACATACT TACCCACTTC AAGGGATTTT GGAACGTTGT	360
GAATAACATT CCCTTCCTTC GAAATGCAAT TATGAGTTAT GTGTTGACAT CCAGATCACA	420
TTTGATTGAC AGTCCACCAA CTTACAATGC TGAATATGGC TACAAAAGCT GGAAGCCTT	480
CTCTAACCTC TCCTATTATA CTAGAGCCCT TCCTCCTGTG CCTGATGATT GCCCGACTCC	540
CTTGGGTGTC AAAGGTAAAA AGCAGCTTCC TGATTCAAAT GAGATTGTGG AAAAATTGCT	600
TCTAAGAAGA AAGTTCATCC CTGATCCCCA GGGCTCAAAC ATGATGTTTG CATTCTTTGC	660
CCAGCACTTC ACGCACCAGT TTTTCAAGAC AGATCATAAG CGAGGGCCAG CTTTCACCAA	720
CGGGCTGGGC CATGGGGTGG ACTTAAATCA TATTTACGGT GAAACTCTGG CTAGACAGCG	780
TAAACTGCGC CTTTTCAAGG ATGGAAAAAT GAAATATCAG ATAATTGATG GAGAGATGTA	840
TCCTCCCACA GTCAAAGATA CTCAGGCAGA GATGATCTAC CCTCCTCAAG TCCCTGAGCA	900
TCTACGGTTT GCTGTGGGGC AGGAGGTCTT TGGTCTGGTG CCTGGTCTGA TGATGTATGC	960
CACAATCTGG CTGCGGGAAC ACAACAGAGT ATGTGATGTG CTTAAACAGG AGCATCCTGA	1020
ATGGGGTGAT GAGCAGTTGT TCCAGACAAG CAGGCTAATA CTGATAGGAG AGACTATTAA	1080
GATTGTGATT GAAGATTATG TGCAACACTT GAGTGGCTAT CACTTCAAAC TGAAATTTGA	1140
CCCAGAACTA CTTTTCAACA AACAAATCCA GTACCAAAAT CGTATTGCTG CTGAATTTAA	1200
CACCCTCTAT CACTGGCATC CCCTTCTGCC TGACACCTTT CAAATTCATG ACCAGAAATA	1260
CAACTATCAA CAGTTTATCT ACAACAATC TATATTGCTG GAACATGGAA TTACCCAGTT	1320

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TGTTGAATCA TTCACCAGGC AAATTGCTGG CAGGGTTGCT GGTGGTAGGA ATGTTCCACC 1380  
CGCAGTACAG AAAGTATCAC AGGCTTCCAT TGACCAGAGC AGGCAGATGA AATACCAGTC 1440  
TTTTAATGAG TACCGCAAAC GCTTTATGCT GAAGCCCTAT GAATCATTG AAGAACTTAC 1500  
AGGAGAAAAG GAAATGTCTG CAGAGTTGGA AGCACTCTAT GGTGACATCG ATGCTGTGGA 1560  
GCTGTATCCT GCCCTTCTGG TAGAAAAGCC TCGGCCAGAT GCCATCTTTG GTGAAACCAT 1620  
GGTAGAAGTT GGAGCACCAT TCTCCTTGAA AGGACTTATG GGTAATGTTA TATGTTCTCC 1680  
TGCCTACTGG AAGCCAAGCA CTTTTGGTGG AGAAGTGGGT TTTCAAATCA TCAACACTGC 1740  
CTCAATTCAG TCTCTCATCT GCAATAACGT GAAGGGCTGT CCCTTTACTT CATTCACTGT 1800  
TCCAGATCCA GAGCTCATTA AACAGTCAC CATCAATGCA AGTTCTTCCC GCTCCGGACT 1860  
AGATGATATC AATCCCACAG TACTACTAAA AGAACGGTCG ACTGAACTGT AGAAGTCTAA 1920  
TGATCATATT TATTTATTTA TATGAACCAT GTCTATTAAT TTAATTATTT AATAATATTT 1980  
ATATTAACT CTTATGTTA CTTAACATCT TCTGTAACAG AAGTCAGTAC TCCTGTTGCG 2040  
GAGAAAGGAG TCATACTTGT GAAGACTTTT ATGTCACTAC TCTAAAGATT TTGCTGTTGC 2100  
TGTTAAGTTT GGAAAACAGT TTTTATTCTG TTTTATAAAC CAGAGAGAAA TGAGTTTGA 2160  
CGTCTTTTTA CTGAATTTT AACTTATATT ATAAGGACGA AAGTAAAGAT GTTTGAATAC 2220  
TTAAACACTA TCACAAGATG CCAAATGCT GAAAGTTTTT AACTGTCTGA TGTTCCTAAT 2280  
GCATCTTCCA TGATGCATTA GAAGTAACTA ATGTTTGAAA TTTTAAAGTA CTTTGGGTA 2340  
TTTTTCTGTC ATCAAACAAA ACAGGTATCA GTGCATTATT AAATGAATAT TTAAATTAGA 2400  
CATTACCAGT AATTTTATGT CTACTTTTTA AAATCAGCAA TGAAACAATA ATTTGAAATT 2460  
TCTAAATTCA TAGGGTAGAA TCACCTGTAA AAGCTTGTTT GATTTCTTAA AGTTATTAAA 2520  
CTTGACATA TACCAAAAAG AAGCTGTCTT GGATTTAAAT CTGTAAAATC AGATGAAATT 2580  
TACTACAAT TGCTTGTTAA AATATTTTAT AAGTGATGTT CCTTTTTCAC CAAGAGTATA 2640

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AACCTTTTTA GTGTGACTGT TAAAACTTCC TTTTAAATCA AAATGCCAAA TTTATTAAGG 2700  
TGGTGGAGCC ACTGCAGTGT TATCTCAAAA TAAGAATATC CTGTTGAGAT ATTCCAGAAT 2760  
CTGTTTATAT GGCTGGTAAC ATGTAAAAAC CCCATAACCC CGCCAAAAGG GGTCTACCC 2820  
TTGAACATAA AGCAATAACC AAAGGAGAAA AGCCCAAATT ATTGGTTCCA AATTTAGGGT 2880  
TTAAACTTTT TGAAGCAAAC TTTTTTTTAG CCTTGTGCAC TGCAGACCTG GTA CTCAGAT 2940  
TTTGCTATGA GGTAAATGAA GTACCAAGCT GTGCTTGAAT AACGATATGT TTTCTCAGAT 3000  
TTTCTGTTGT ACAGTTTAAT TTAGCAGTCC ATATCACATT GCAAAAAGTAG CAATGACCTC 3060  
ATAAAATACC TCTTCAAAAT GCTTAAATTC ATTTACACA TTAATTTTAT CTCAGTCTTG 3120  
AAGCCAATTC AGTAGGTGCA TTGGAATCAA GCCTGGCTAC CTGCATGCTG TTCCTTTTCT 3180  
TTTCTTCTTT TAGCCATTTT GCTAAGAGAC ACAGTCTTCT CAAACACTTC GTTCTCCTA 3240  
TTTTGTTTTA CTAGTTTTAA GATCAGAGTT CACTTTCTTT GGA CTGCTGCC TATATTTTCT 3300  
TACCTGAACT TTTGCAAGTT TTCAGGTAAA CCTCAGCTCA GGA CTGCTAT TTAGCTCCTC 3360  
TTAAGAAGAT TAAAAAAAAA AAAAAAG 3387

FIG.2C

SUBSTITUTE SHEET

## INTERNATIONAL SEARCH REPORT

In national application No.

PCT/CA 93/00547

## A. CLASSIFICATION OF SUBJECT MATTER

IPC5: C12Q 1/00 // C 12 N9/02

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC5: C12Q, C12N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPIL, CLAIMS, MEDLINE

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	Proc. Natl. Acad. Sci. USA, Volume 89, August 1992, Timothy Hla et al., "Human cyclooxygenase-2 cDNA", page 7384 - page 7388, see the whole document especially fig. 1 --	15-20
A	Proc. Natl. Acad. Sci. USA, Volume 89, June 1992, M. Kerry O'Banion et al., "cDNA cloning and functional activity of a glucocorticoid-regulated inflammatory cyclooxygenase", page 4888 - page 4892, subheading: "cDNA Expression and Prostaglandin E2" --	1-14
A	JP, A, 1228479 (MEIJI MILK PROD CO LTD), 12 Sept 1989 (12.09.89) --	15-20

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

## \* Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

22 March 1994

Date of mailing of the international search report

07.04.94

Name and mailing address of the International Searching Authority authorized officer



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## INTERNATIONAL SEARCH REPORT

International application No.

PCT/CA 93/00547

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP, A, 63157980 (CHISSO CORP), 30 June 1988 (30.06.88)  -- -----	1-14

# INTERNATIONAL SEARCH REPORT

International application No.

PCT/CA 93/00547

## Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

See the attached sheet!

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☒ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

## Box II Cont.

Initially, all these subject matters were included in the search. However, it soon became obvious that pertinent prior art exists, making it necessary to reconsider the technical relationship between different solutions revealed in the claims. This prior art is:

Proc. Natl. Acad. Sci. USA v. 89; pages 7384-7388, Hla T. et al. Human cyclooxygenase-2 cDNA".

This document, which represent the state of the art, illustrates that human cyclooxygenase-2 cDNA is known per se.

A strict new common concept of invention cannot be identified. The independent claims represent independent subject matter, and therefore lack unity with each other. However, ISA has arrived at a principle of division based on the description and the prior art:

1. Claims 1-14 concerning an assay evaluating inhibition of cyclooxygenase-2 in comparison with cyclooxygenase-1.
2. Claims 15-20 concerning human cyclooxygenase-2 cDNA, human cyclooxygenase-2 and a system for stable expression of human cyclooxygenase-2.

**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

26/02/94

International application No.  
PCT/CA 93/00547

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP-A- 1228479	12/09/89	NONE	
JP-A- 63157980	30/06/88	JP-B- 1004757	26/01/89
		JP-C- 1521356	12/10/89